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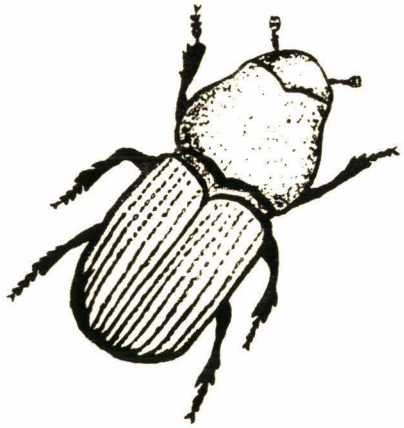
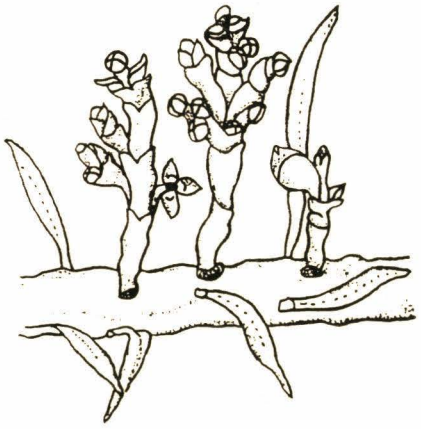
MONTANA

FOREST PEST CONDITIONS AND PROGRAM HIGHLIGHTS

1988





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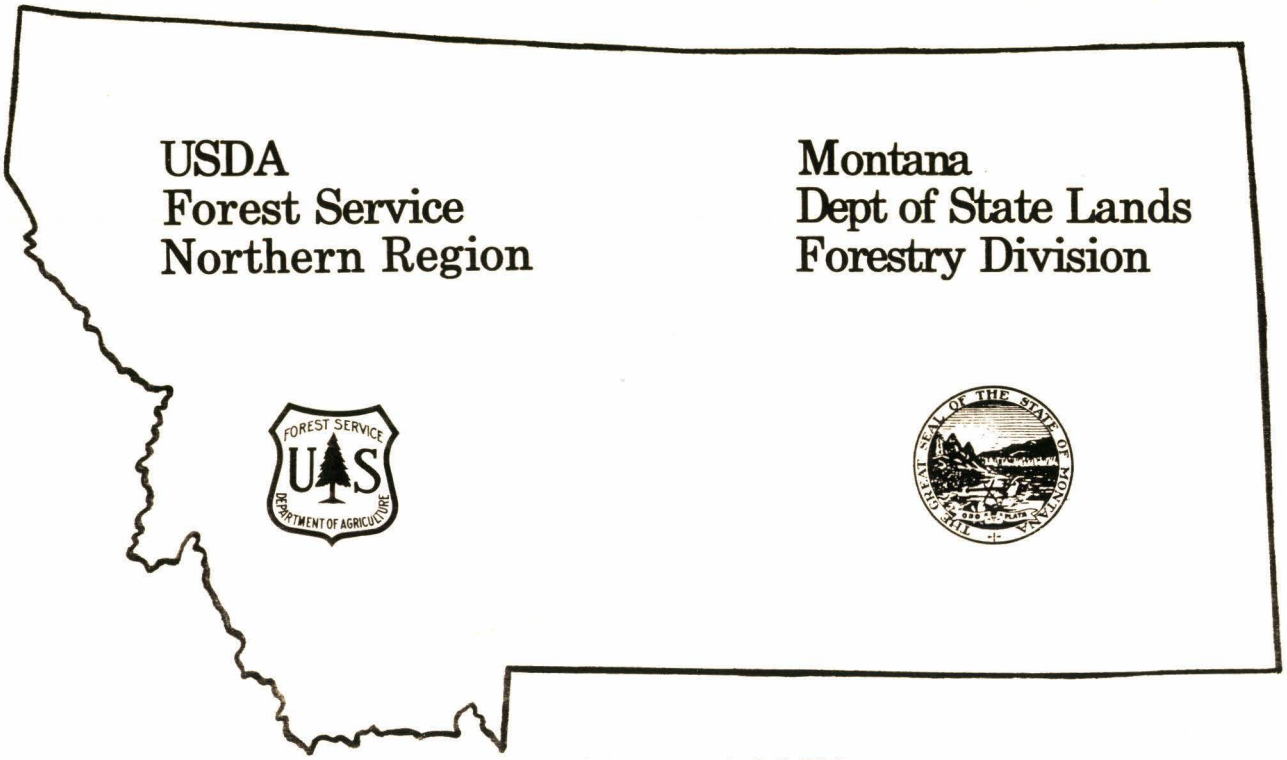

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INTRODUCTION

This report summarizes pest conditions in Montana during 1988 and was prepared jointly by Montana Department of State Lands, Forestry Division and USDA Forest Service, Timber, Cooperative Forestry and Pest Management.

Information for the report was obtained from aerial and ground surveys and on-site evaluations. The major pests on forested land within the State have been identified and the acres affected have been listed by ownership.

SUMMARY OF CONDITIONS

Major forest pests that caused widespread damage in Montana in 1988 were mountain pine beetle, western spruce budworm, root diseases and dwarf mistletoes. Overall mountain pine beetle-caused mortality in all tree host species decreased again in 1988, but infestations still affected nearly 547,000 acres of all ownerships. Millions of trees were killed. Mortality caused by Douglas-fir beetle has increased considerably and is heaviest on the Kootenai National Forest. Spruce beetle activity was very low. Pine engraver and western pine beetle populations increased significantly. Western spruce budworm defoliation increased, with over 2 million acres observed. The largest increases were on the Helena and Lewis & Clark reporting areas.[1] Douglas-fir tussock moth defoliated some ornamental blue spruce, but populations remained relatively low in surrounding forest areas. Two adult male gypsy moths were caught in detection traps. Forest tent caterpillar again defoliated deciduous trees in several areas. Some localized pine butterfly populations have increased. Pine sawyers transported to Billings in large amounts of firewood salvaged from the Bull Mountains fire killed a number of ornamental pines in the city.

Root diseases were the most serious disease problem in Montana forests, especially west of the Continental Divide. Dwarf mistletoes also continued to be one of the most damaging diseases, causing losses second only to root diseases. Local infections of Diplodia shoot blight continued to be severe. Fusarium root disease was a major problem of containerized coniferous seedling nurseries in Montana. Cylindrocarpon root disease occurred on containerized conifer seedlings at most nurseries, as did grey mold, Sirococcus blight, Phoma blight, and Pythium root disease. Dutch elm disease continued to cause much economic loss. Great Falls removed over 700 American elms in 1988 and Billings removed over 200. Drought-associated damage was apparent at many western Montana locations, affecting Douglas-fir, western redcedar and ponderosa pine.

INSECTS

Bark Beetles

Mountain Pine Beetle

Overall, mountain pine beetle-caused mortality in all host species continued to decrease this year. Only a few areas of building populations remained in the State. Total infestation on all ownerships declined from approximately 707,000 acres in 1987 to nearly 547,000 acres in 1988 (see map). Federal lands affected by the mountain pine beetle total over 430,000 acres of lodgepole pine, 13,000 acres of ponderosa pine, 100 acres of whitebark pine, and 600 acres of western white pine (Table 1). State and private lands infested exceeded 92,000 acres of lodgepole pine, 9,800 acres of ponderosa pine, 3 acres of whitebark pine, and 38 acres of western white pine (Table 2). Although mountain pine beetle populations generally decreased statewide, the beetle still killed millions of trees and affected visual quality, watershed, wildlife, and timber products.

[1]Reporting area includes data from all land ownerships within a National Forest boundary.

Table 1.--Acres of mountain pine beetle-caused mortality on Federal lands in Montana and Yellowstone National Park (NP)--1987 and 1988.

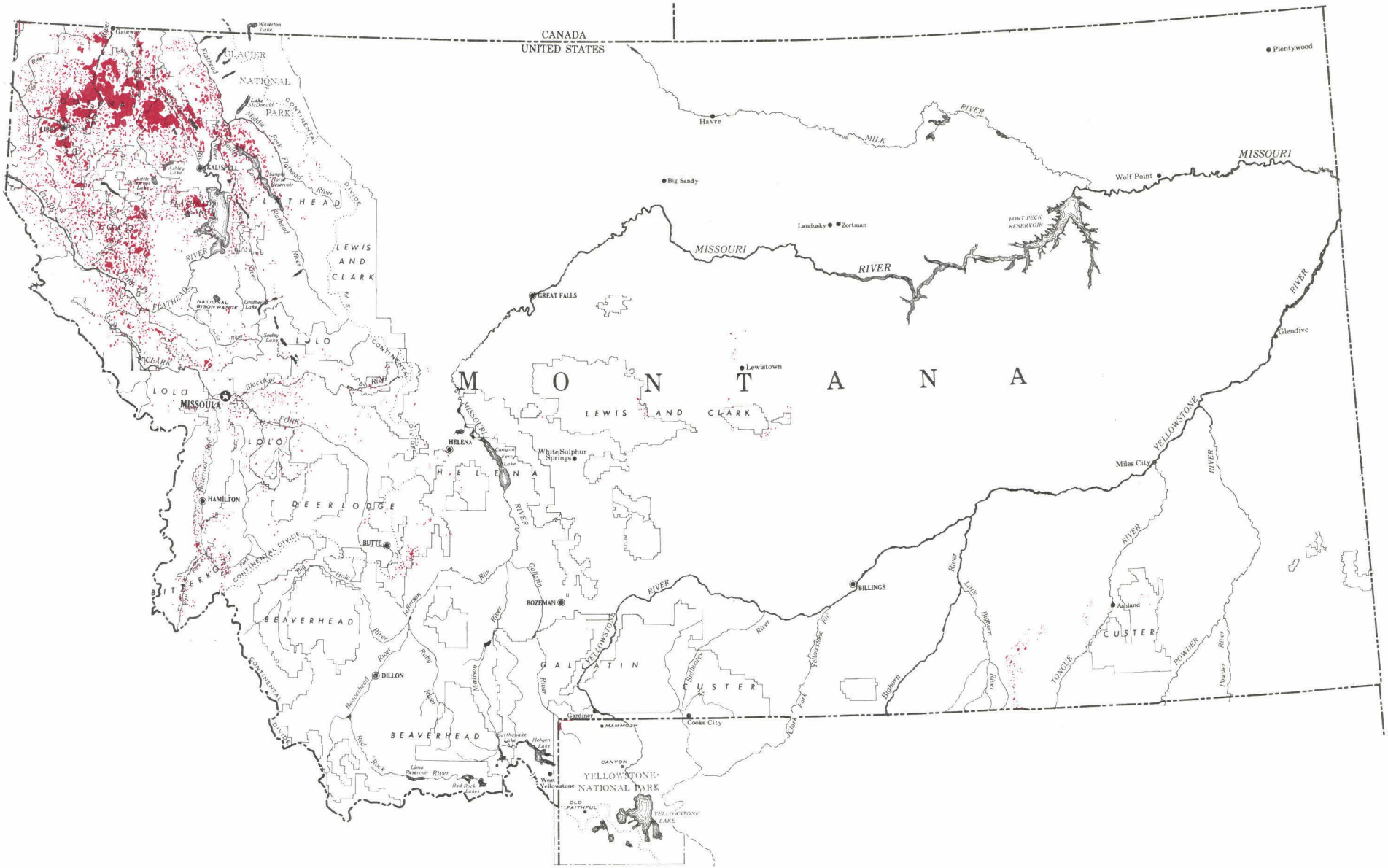
	1987				1988			
Area	LPP1/	PP	WBP	WWP	LPP	PP	WBP	WWP
Beaverhead NF	18	–	1	–	4	–	–	–
Bitterroot NF	2	2,713	4	–	–	2,399	1	–
Custer NF	–	–	–	–	–	2	–	–
Deerlodge NF	1,697	1	–	–	1,618	5	–	–
Flathead NF	181,149	757	551	767	93,106	39	98	109
Gallatin NF	455	–	–	–	–	–	–	–
Helena NF	305	403	18	–	1	8	–	–
Kootenai NF	272,205	2,713	–	1,772	304,785	6,306	21	458
L&C NF	15	1,124	1	–	1	179	–	–
Lolo NF	23,972	736	43	3	28,051	813	3	84
TOTAL NF	479,819	13,092	1,473	2,542	427,566	9,751	123	651
Glacier NP	1,183	–	–	31				
Yellowstone NP	–	–	–	–				
TOTAL NP	1,183	–	–	31				
Blackfeet IR	41	–	–	–				
Crow IR	–	3,928	–	–	–	3.635	–	–
Flathead IR	2,239	1,917	2	–	1,429	47	5	2
Ft. Belknap IR	–	155	–	–				
N. Cheyenne IR	–	693	–	–	–	19	–	–
Rocky Boy's IR	24	17	–	–				
TOTAL IR	2,304	6,710	2	–				
TOTAL BLM	3,668	593	–	–	1,037	235	1	0
TOTAL FEDERAL	486,974	20,395	1,475	2,573	430,032	13,687	129	653

1/ LPP = lodgepole pine PP = ponderosa pine WBP = whitebark pine WWP = western white pine

Table 2.--Acres of mountain pine beetle-caused mortality on State and private lands, 1987-1988.

	1 9 8 7				1 9 8 8			
Area	LPP 1/	PP	WBP	WWP	LPP	PP	WBP	WWP
Beaverhead	6	--	--	--	3	--	--	--
Bitterroot	1	2,361	--	--	--	4,243	--	--
Custer	--	--	--	--	--	--	--	--
Deerlodge	300	--	--	--	147	4	--	--
Flathead	51,071	12,167	--	71	13,643	2,088	--	4
Gallatin	311	--	--	--	--	--	--	--
Garnets	53	1,392	--	--	3	634		
Helena	116	167	1	--	1	18	--	
Kootenai	36,040	3,180	127	--	34,276	1,705	--	7
Lewis & Clark	106	191	--	--	--	425	--	--
Lolo	22,063	1,169	1	--	10,092	331	2	1
Stillwater SF	58,717	647	420	--	28,240	1	1	21
Swan River SF	4	107	--	279	4	--	5	5
Thompson River SF	4,570	207	--	--	5,921	391	--	--
TOTALS	173,358	21,482	549	350	92,330	9,840	3	38

1/ LPP = lodgepole pine PP = ponderosa pine WBP = whitebark pine WWP = western white pine



Areas of mountain pine beetle infestations in Montana and Yellowstone National Park (all host species), 1988.

Beaverhead Reporting Area - The mountain pine beetle has virtually left this area with only 9 acres of Federal, State, and private land reported infested.

Bitterroot Reporting Area - Mortality increased in ponderosa pine on State and private lands where over 4,200 acres were reported infested compared to 2,361 reported last year. Acres infested on Federal land decreased from 2,713 in 1987 to 2,399 in 1988. Mountain pine beetle populations increased in the East Fork of the Bitterroot River drainage.

Custer Reporting Area - Mountain pine beetle activity continued to be very low on the Custer. Only 2 acres of ponderosa pine were reported infested, though not all of the Custer National Forest (NF) was flown due to fires in several areas.

Deerlodge Reporting Area - Lodgepole pine mortality was slightly lower in 1988 with 1,765 acres infested compared to 1,997 in 1987. Though some stands have experienced population buildups, many have been brought under management.

Flathead Reporting Area - On all lands, 106,749 acres of lodgepole pine, 2,127 acres of ponderosa pine, 98 acres of whitebark pine, and 113 acres of western white pine were infested by the mountain pine beetle in 1988. This was more than a 50 percent decrease over last year.

Gallatin Reporting Area - The mountain pine beetle infestation on the Gallatin has collapsed to endemic levels. Widely scattered mortality was observed, though most of the Forest was not flown.

Garnets Reporting Area - Only 637 acres of State and private lands were infested this year. Most of the activity was in ponderosa pine stands. More than twice as many acres were infested in 1987.

Helena Reporting Area - Populations decreased dramatically from nearly 1,000 infested acres of all hosts in 1987 to only 28 acres in 1988.

Kootenai Reporting Area - Nearly 350,000 acres were infested on all ownerships in all host species. This was slightly more than last year's 321,000 acres. Stands within the Kootenai Reporting Area had some of the most active mountain pine beetle infestations remaining in the State.

Lewis and Clark Reporting Area - Mountain pine beetle populations continued to decline with about 600 infested acres reported compared to over 1,500 acres in 1987.

Lolo Reporting Area - Overall mortality has decreased in this area with over 39,000 acres infested compared to over 48,000 in 1987. Mountain pine beetle populations increased in lodgepole pine on private land south of the city of Plains, and on Federal land north of there.

Glacier National Park - Though the Park was not flown in 1988, small and scattered groups of lodgepole pine killed by mountain pine beetle were found in the southern portion of the Park along the Middle Fork of the Flathead River.

Yellowstone National Park - Mountain pine beetle infestations in lodgepole pine were virtually nonexistent in the Park. Remnant beetle populations remained in limber pine stands near Mammoth.

Blackfeet Indian Reservation - Though susceptible lodgepole pine stands remained on the western portion of the Reservation, beetle populations were nearly at endemic levels.

Crow Indian Reservation - Infested acres of ponderosa pine decreased slightly in this area with 3,635 acres recorded.

Flathead Indian Reservation - Mortality in all hosts decreased this year with 1,429 acres of infested lodgepole pine and 47 acres of infested ponderosa pine reported.

Fort Belknap Indian Reservation - Reservation not flown in 1988 because beetle populations previously recorded in the southern portion of the Reservation were significantly lower in 1987.

Northern Cheyenne Indian Reservation - Mountain pine beetle activity has dropped considerably to only 19 acres of infested ponderosa pine reported.

Rocky Boy's Indian Reservation - Not flown in 1988. Populations had declined to only 41 acres infested in 1987.

Stillwater State Forest - Infested acres have decreased to about half that of last year with just over 28,000 acres reported on State and private lands.

Swan River State Forest - Beetle activity has decreased with only 5 acres of infested western white pine and 4 acres of infested lodgepole pine reported.

Thompson River State Forest - Infested acres of lodgepole pine have increased this year to nearly 6,000 compared to 4,500 recorded last year. Mortality in ponderosa pine continued also with nearly 400 acres infested.

Douglas-Fir Beetle

Mortality caused by the Douglas-fir beetle has increased considerably throughout the State. Most activity was reported from the Beaverhead, Kootenai, and Lolo Reporting Areas (Table 3). Biological evaluations conducted on the Beaverhead and Kootenai NF's indicated increasing beetle populations. Infested areas on the Beaverhead NF were associated with heavy spruce budworm defoliation and top kill. Many of the infested areas on the Kootenai NF were associated with root disease centers and aggravated by extremely dry weather. Increased Douglas-fir beetle activity is expected to continue.

Spruce Beetle

Spruce beetle activity was very low. Less than 30 infested acres were reported in the entire State. Mortality was recorded from the Bitterroot, Flathead, and Kootenai Reporting Areas (Table 3).

Pine Engraver

Pine engraver activity detected from aerial surveys increased to 75 infested acres this year (Table 3). Most recorded activity was on the Flathead Indian Reservation (IR). However, ground surveys indicated actual mortality in western Montana was much greater. Considerable activity was noted throughout the Clark Fork River drainage. Normally not a major pest, pine engraver populations increase during periods of drought, causing mortality in weakened pines. This beetle is also found in tops of trees infested by mountain pine beetle and western pine beetle. If our current drought persists, mortality caused by this beetle will continue.

Table 3.--Acres of bark beetle-caused mortality (other than mountain pine beetle) in Montana and Yellowstone National Park--1988.

	Douglas-fir beetle		Spruce beetle		Pine engraver		Western pine beetle		Western balsam bark beetle		Fir engraver	
Reporting area	Fed.	S&PF	Fed.	S&PF	Fed.	S&PF	Fed.	S&PF	Fed.	S&PF	Fed.	S&PF
Beaverhead	620	--	--	--	--	--	--	--	2	--	--	--
Bitterroot	39	2	2	--	2	--	--	--	6	1	--	--
Custer	--	--	--	--	--	--	--	--	--	--	--	--
Deerlodge	--	1	--	--	--	1	--	--	1	--	--	--
Flathead	84	26	9	5	--	--	--	--	5	--	--	1
Gallatin	1	--	--	--	--	--	--	--	--	--	--	--
Garnets	--	18	--	--	--	--	--	--	--	--	--	--
Helena	18	--	--	--	--	--	--	--	1		--	--
Kootenai	1,016	4	11	--	--	--	--	--	1	--	--	--
Lewis & Clark	--	--	--	--	--	1	--	--	--	--	--	--
Lolo	647	17	--	--	1	1	1	--	2	1	47	--
Glacier NP										--	--	--
Yellowstone NP												
Blackfeet IR												
Crow IR												
Flathead IR	10	--	--	--	69	--	--	--	1	--	13	--
Ft. Belknap IR												
N. Cheyenne IR												
Rocky Boy's IR												
BLM	4	--	--	--	--	--	--	--	--	--	--	--
Stillwater SF	--	--	--	--	--	--	--	--	--	--	--	--
Swan River SF	9	31	--	--	--	--	--	--	--	--	--	--
Thompson River SF	--	1	--	--	--	--	--	--	--	--	--	--
TOTAL	2,448	100	22	5	72	3	1	--	19	2	60	44

Western Pine Beetle

Ground surveys indicated that western pine beetle populations have increased substantially in western Montana ponderosa pine stands. Increased activity was especially noted on the Superior Ranger District (RD), Lolo NF. This increase was probably due to beetles attacking trees affected by the continued drought.

Western Balsam Bark Beetle

Only 21 acres of scattered subalpine fir mortality caused by this beetle were recorded throughout the State (Table 3).

Fir Engraver

Fir engraver populations also tend to increase during periods of drought. In grand fir, 47 infested acres were recorded from the Lolo Reporting Area, and 13 acres from the Flathead IR (Table 3).

Ash Bark Beetle

High population levels of ash bark beetle continued in some areas of north-central and northeastern Montana during 1988. Green ash trees in cities and windbreaks that were weakened and damaged by adverse weather conditions the the springs of 1986 and 1987 provided abundant host material to maintain these populations in Havre, Glasgow, Lewistown and other areas. Beetle populations are expected to decline and healthy trees should remain unaffected.

Defoliators

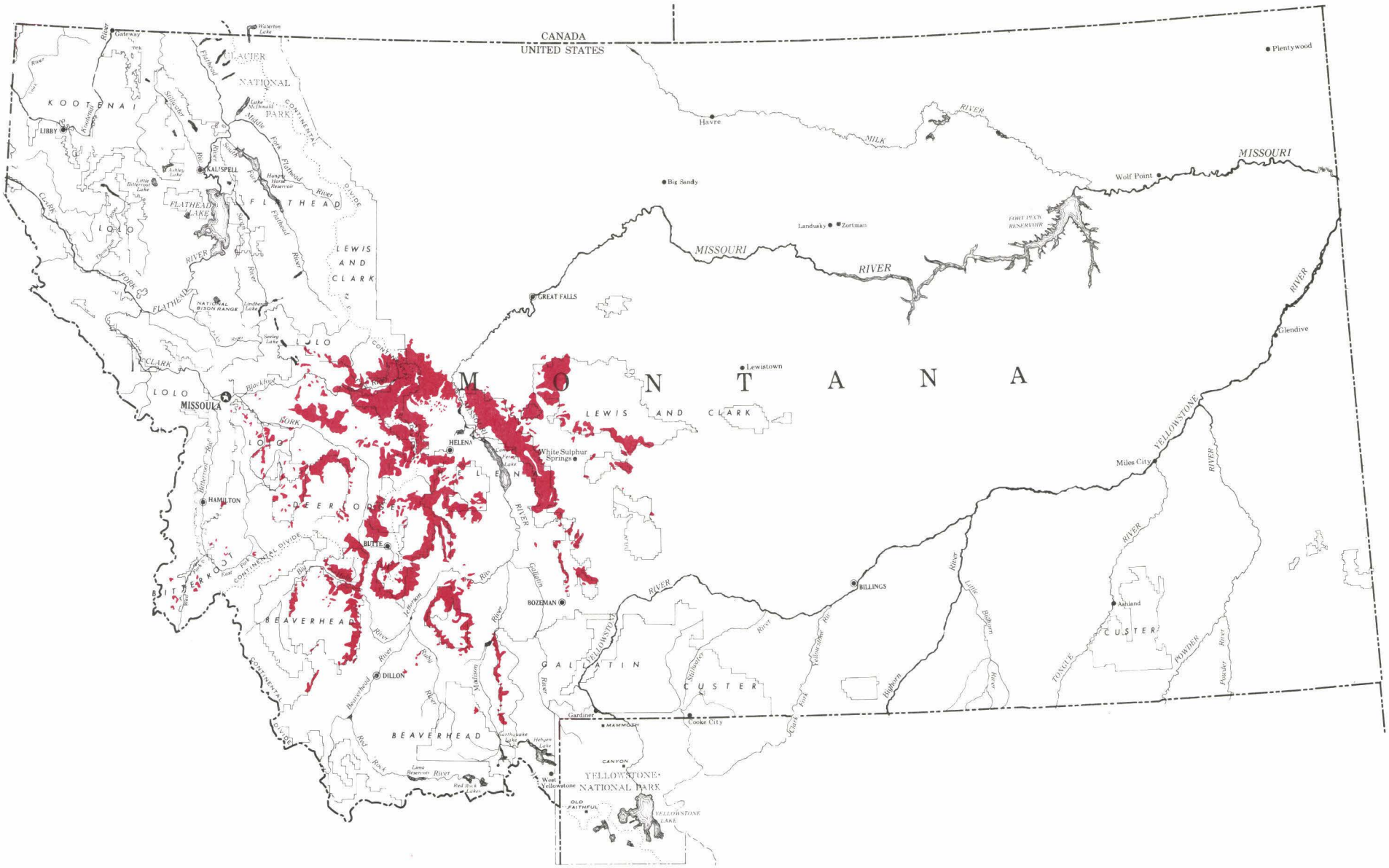
Western Spruce Budworm

Acres of aerially visible defoliation by western spruce budworm on all ownerships in Montana totaled 2,063,995 in 1988, an increase from the 1,806,469 acres defoliated in 1987 (see map). The Deerlodge, Garnets, Helena, and Lewis & Clark Reporting Areas showed increases in defoliated acres in 1988 over 1987 (Table 4). The largest increases were on the Helena and Lewis & Clark Reporting Areas. Defoliation on the remaining Reporting Areas decreased.

Table 4.--Acres of aerially visible western spruce budworm defoliation on all ownerships in Montana--1987 and 1988.

	All ownership		1988 Acres by ownership			
Reporting area	1987	1988	NFS	BLM	State	Private
Beaverhead	279,827	205,530	151,691	25,125	4,640	24,074
Bitterroot	60,709	8,926	6,978	--	277	1,671
Custer	24,910	--	--	--	--	--
Deerlodge	442,404	469,122	245,802	54,631	26,908	141,781
Gallatin	71,192	39,704	16,463	--	--	23,241
Garnets	63,615	90,157	--	20,924	8,371	60,862
Helena	659,549	1,027,059	515,003	55,343	64,908	391,805
Lewis & Clark	119,573	172,085	129,929	3,515	2,241	36,400
Lolo	62,051	51,412	36,096	104	2,576	12,636
Yellowstone NP	4,464	--	--	--	--	--
Flathead IR	18,175	--	--	--	--	--
TOTALS	1,806,469	2,063,995	1,101,962	159,642	109,921	692,470

Yellowstone National Park was not surveyed in 1988.



Western spruce budworm defoliation visible from the air in Montana and Yellowstone National Park, 1988.

Douglas-fir Tussock Moth

Defoliation by Douglas-fir tussock moth of ornamental blue spruce was observed in several locations including Missoula, Polson, Bigfork, and Kalispell in 1988. Such defoliation has usually indicated that populations were increasing in the surrounding forest stands.

Pheromone trap catches of adult male moths were higher at most of the 33 permanent trapping sites in Montana, but none of the sites averaged more than 25 moths per trap. One site near Frenchtown averaged 20.8 moths per trap; the rest averaged less than 10 per trap. No defoliation of forest trees was observed in Montana in 1988.

Gypsy Moth

In 1988, two male gypsy moths were caught by Montana Department of Agriculture in detection traps in Montana, one at a KOA Campground in Gallatin Gateway and the other in Helena. Trapping in 1989 will continue to be coordinated among Montana Department of State Lands, Montana Department of Agriculture, APHIS and the USDA Forest Service.

Forest Tent Caterpillar

Forest tent caterpillar defoliated deciduous trees, mainly cottonwoods, in many areas of western Montana including the Missoula area, Kalispell, Noxon, Polson, Arlee, and the Fish Creek and Petty Creek drainages west of Missoula. Populations and resulting defoliation declined in some areas where infestations have persisted for as long as 4 years, while other areas were defoliated for the first time. Indications are that populations will decline in most of the infested areas.

Pine Butterfly

Some substantial increases in pine butterfly populations were observed in three localized areas during 1988. They were the Lost Lake area southeast of Polson and the Skalkaho Creek and Lost Horse Creek drainages south of Hamilton. Some egg sampling done at the Skalkaho Creek area indicated that population levels will be high again in 1989. No significant defoliation from pine butterfly larvae was observed in this or the other areas in 1988.

Miscellaneous Insects

Lodgepole Terminal Weevil

Damage from the lodgepole terminal weevil has been surveyed on the Wisdom RD, Beaverhead NF, and the Glacier View RD and Tally Lake RD, Flathead NF in young lodgepole pine stands. A survey conducted in 1988 on the Jocko lodgepole pine test plantation, Flathead IR indicated 10 percent of the trees were infested there. The lodgepole terminal weevil infests terminals of lodgepole pines 3 to 25 feet tall. As trees grow into this size class, the incidence of weevil damage is expected to increase.

Pine Sawyer

A number of ornamental ponderosa and Scots pines were killed in Billings city parks and yards by pine sawyers, species of longhorned borers belonging to the family Cerambycidae. This group of beetles normally attacks dying or recently dead and down trees, and healthy trees are not at risk. However, high populations of adult sawyers occurred in Billings because of large amounts of infested firewood brought in by people from the Bull Mountains fire. The fire-killed timber was infested by beetles shortly after the burn. When the beetles emerged in Billings, they attacked ornamental pines in the city. Sawyer damage is not expected to continue.

DISEASES

Root Diseases

Root diseases were the number one disease problem in Montana forests, particularly west of the Continental Divide. Root disease-caused mortality over a broad range of stand conditions has been evaluated in several compartments on the Idaho Panhandle NF's, Clearwater NF and Flathead IR. Permanent plots have been remeasured on an annual basis to detect yearly fluctuation in mortality rates. Annual mortality rates have varied considerably among stands. The average rates for Douglas-fir and grand fir were 4.3 and 2.1 percent per year, respectively. These mortality rates were higher than those of other tree species and those due to all other causes.

The plots were established and are monitored by District and Bureau of Indian Affairs (BIA) personnel with training and financial support from Pest Management personnel in the Regional Office of the USDA Forest Service. These projects will be used in development of a root disease hazard rating system which will provide needed information for planning harvest activities. It will help to identify stands which are losing or soon will be losing the greatest volumes of timber. These stands can then be scheduled for harvest to avert much of the loss of value to root disease mortality. Information from hazard rating will also be used to assess root disease impact over large areas and adjust productivity projections for stands and compartments. Additionally, the Idaho Panhandle NF's and Flathead IR projects include many stands which have been or are scheduled for commercial thinning. They will be monitored following thinning to evaluate the effects of thinning on mortality rates.

Foresters on the Flathead IR called our attention to a disconcerting amount of ponderosa pine mortality in the Sunrise Spring Logging Unit in the Camas Creek area. The problem was due to annosus root disease. Trees of all sizes and age classes were dying in this area, which had been cut over several times in past decades. The fungus infects stumps with air-borne spores following the harvest of old-growth trees (approximately 18 inches d.b.h. or larger). The fungus then spread to adjacent, residual crop trees via root contact with the stump. Unevenaged management perpetuates this root disease by requiring frequent stand entries, thus creating ideal conditions for the disease. Bureau of Indian Affairs foresters are seeking alternatives to unevenaged management in stands that are infested with annosus root disease.

A project was also completed on the Flathead IR to evaluate stump infection by annosus root disease in a ponderosa pine commercial thinning sale area. The thinning was completed in March and only 2 percent of the stumps were infected at that time. By September the stump infection rate was 42 percent, indicating that stump infection taking place after thinning may have contributed greatly to the inoculum load in the stand.

Root disease was evaluated as a possible predisposing factor in mountain pine beetle attacks in some lodgepole pine stands. Stands with sub-epidemic levels of mountain pine beetle populations were examined for correlations between root pathogen damage and beetle attacks. On the Beaverhead NF, feather root rot was indicated as a predisposing factor for stands attacked by bark beetles other than the mountain pine beetle. Armillaria root rot was associated with mountain pine beetle and other bark beetle attacks in thinned, small-diameter stands on the Hungry Horse RD of the Flathead NF.

Dwarf Mistletoes

Dwarf mistletoes continued to reign as one of the most damaging disease problems in Montana forests. Douglas-fir and western larch dwarf mistletoes are present on the west side of the Continental Divide, while dwarf mistletoe on lodgepole pine is found on both eastern and western forests. Ponderosa pine dwarf mistletoe has not yet been reported in the State.

Damages caused by dwarf mistletoes are second only to root diseases in Montana. Loss assessment surveys conducted in 1978, 1979, and 1980 still provide the most accurate estimates of annual volume losses for each host species by land ownership. At that time, it was estimated that 16 percent, 30 percent, and 33 percent of the Douglas-fir, western larch, and lodgepole pine commercial forest types, respectively, were infested with the parasite. Dwarf mistletoe-caused growth reduction was assessed at 33.2 mm per year with a window of accuracy of ± 20 percent. Although we believe that dwarf mistletoe losses have since been reduced in managed, regenerated stands, they continued to spread at a rate of 1 to 2 feet per year in unmanaged stands. Previous dwarf mistletoe loss assessments, therefore, are still useful in reporting regional volume reductions and acreages affected until survey information is updated.

Dwarf mistletoe management is receiving increasing focus on Region 1 forests for several reasons. Timber, Cooperative Forestry and Pest Management (TCFPM) training programs are successfully communicating the importance and practicality of dwarf mistletoe control to forest and district personnel. Hence, more and more silvicultural prescriptions contain dwarf mistletoe considerations, acknowledging the impact these pathogens have on future forest health. At the same time, as more and more people grow to use and enjoy our forest lands, there arises conflict between social values and timber management practices. Forest managers are presented with the dilemma of addressing both visual concerns and biological effects in their stand prescriptions. Subsequently, there exists a knowledge need of highest priority--to provide factual information about the biology and effects of dwarf mistletoes so that both objectives can be achieved wherever possible. This knowledge need is being demonstrated by the increasing requests for technology transfer, technical assistance, and biological evaluations by Forest Service and other land management agencies.

Two such evaluations were completed during FY88. The first was conducted on the Flathead IR, where dwarf mistletoe-infested stands continue to pose management problems on all three of their commercially important timber types. In the early 1970's, the Reservation initiated a thinning-sanitation program in lightly infested stands (less than one-third of the stems infected) as an alternative to clearcutting. In 1987, a follow-up examination showed these attempts to be largely unsuccessful, with some stands 50 percent infested only 8 to 10 years after treatment. In 1988, an evaluation was conducted to determine whether another series of thinning-sanitation cuts would successfully reduce the parasite to manageable levels. A Douglas-fir stand which had been treated in 1980 was chosen for the study. At a "production rate," infected individuals were marked for removal, with 43 percent of the trees displaying visible dwarf mistletoe symptoms just 8 years after treatment. After felling and examining the purported "clean" trees, it was found that an additional 30 percent of them were infected. These results demonstrate the difficulty and error involved in selectively "weeding out" dwarf mistletoe in infested stands. The Flathead IR is presently developing new strategies to manage this problem with assistance from TCFPM.

A second evaluation assessing the growth impact, spread, and intensification of Douglas-fir dwarf mistletoe was completed in cooperation with the Missoula RD, Lolo NF. Permanent plots established in 1970 were remeasured for the fourth time in 1988, with the data to be analyzed in 1989. Such long-term studies are invaluable in that they provide information needed for developing pest management recommendations and computer models which predict host/parasite interactions and disease damage.

Stem Cankers

White Pine Blister Rust

Field performance with respect to white pine blister rust infection is being evaluated in plantations of rust-resistant western white pine. Twenty-six stands were surveyed in Montana and northern Idaho. The plantations ranged from 1 to 20 years of age and had 107 to 386 surviving planted white pines per acre. Infection rates were generally very low in both F_1 (Sandpoint Seed Orchard) and F_2 (Moscow Aboretum) stock types, with some notable exceptions. While 19 of the 26 stands had infection rates of less than 10 percent, four stands which were 4 years old had about 25 percent lethal infections, and a 20-year-old stand was 70 percent lethally infected.

An evaluation of white pine blister rust damage to whitebark pine was made in the Palmer Mountain area of the Gallatin NF north of Yellowstone NP. The disease was found in each of several stands examined, but little damage had occurred. Although branch cankers were found on a number of trees, no tree mortality was attributed to the rust fungus. This was in sharp contrast to the situation further north in Glacier NP and on neighboring Blackfeet IR and Flathead NF lands. Many whitebark pine stands in these areas have suffered severe damage to old-growth trees and regeneration.

Diplodia Shoot Blight

This disease kills current-year shoots, and also forms girdling cankers on infected host branches. Ponderosa pine is presently the only host in Montana, but local infections can be severe. Infestations have been most prominent along the west side of Flathead Lake, in the Lolo Creek drainage southwest of Missoula and along Highway 200 near Plains. The fungus causing the blight is capable of infecting both wounded and stressed trees.

Nursery Diseases

Fusarium Root Disease

Fusarium root disease was a major problem of containerized conifer seedling nurseries in Montana. Losses have been most severe in Douglas-fir and western larch. The disease is caused mostly by *Fusarium oxysporum*, although several other species may be involved. Fungal inoculum is often introduced on infected seed or contaminated containers. Many seedlings may become infected but do not produce disease symptoms. Once disease symptoms appear, efforts to control the disease are largely unsuccessful.

Fusarium root disease occurred at relatively high levels at the Champion Timberlands Nursery, Plains. However, losses were less than in previous years at the Montana Department of State Lands Nursery in Missoula, primarily because of new seed-treatment techniques used at the nursery. Occurrence of this disease continued to be at low levels at the Plum Creek Nursery in Pablo.

Fusarium root disease was also shown to be responsible for mortality of outplanted Douglas-fir and western larch seedlings at a tree improvement plantation near Bigfork.

Several evaluations were conducted in order to formulate more effective control measures for Fusarium root disease of conifer seedlings. Treatments including different concentrations of sodium hypochlorite (bleach) and water heated by microwave treatments were evaluated for western larch seed. The hot water treatments appeared to be more effective in reducing amounts of fungi on a seedlot with high pathogen levels.

An evaluation was conducted at several nurseries in Montana to test the efficacy of a granulated formulation of Banrot® in controlling Fusarium root disease. The fungicide was incorporated into growing media prior to sowing, and disease and seedling development were monitored throughout the growing season. Treatments apparently did not affect disease occurrence or seedling infection. However, treated seedlings were consistently smaller than untreated seedlings. Therefore, it appears that this approach to controlling Fusarium root disease holds little promise.

Several evaluations have indicated that contaminated containers (styroblock and pine cell) may be important sources of fungal inoculum. These evaluations have also indicated that standard steam-cleaning treatments do not adequately reduce this contamination. In one evaluation, fumigation with methyl bromide was also unsatisfactory. Because of the importance of reducing this inoculum source to acceptable levels, evaluations of other potential "cleaning" techniques are planned. One of the methods to be tested is use of sodium

metabisulfite to clean containers. This chemical has shown potential in several nurseries in British Columbia and, if effective, may provide growers with an important alternative to standard techniques.

Another new approach to controlling Fusarium root disease is the use of a biological control agent. *Trichoderma harzianum* has been effective in controlling root diseases on several agricultural and horticultural crops. However, effectiveness on conifer seedlings has not been tested. A new "genetically engineered" strain of the fungus will be evaluated on containerized conifer seedlings in a small test at the Forest Research Nursery, University of Idaho, Moscow this next season. It may be evaluated in an expanded test the following growing season at several other nurseries.

An evaluation of the fate of Fusarium root disease on outplanted containerized seedlings is in its second year. After two growing seasons, the fungus was still detected on the roots of some seedlings, but was limited to the old "plug" roots and had not colonized newly egressed roots. Fusarium root disease was not responsible for any seedling mortality.

Other evaluations into the biology and pathology of *Fusarium* spp. associated with conifer seedling diseases include (1) isozyme analyses using electrophoresis to determine if pathogenicity is related to enzyme patterns, and (2) possible electron microscopic examinations of seed and root rhizospheres to determine behavior of the fungus in these environments.

Soil-borne diseases

For the past 2 years, evaluations have been conducted at the Coeur d'Alene Nursery to determine efficacy of Basamid® fumigation to control bareroot seedling root diseases. This chemical has reduced soil populations of fungi causing damping off root disease but not to the levels possible by fumigation with methyl bromide. Satisfactory disease control has occurred in areas treated with Basamid®. However, pathogen populations have been very low and may increase over time. Repeated soil fumigation with methyl bromide/chloropicrin has greatly reduced background pathogen populations at the nursery. Hopefully, these organisms will not greatly increase after methyl bromide is replaced with Basamid®. Continued monitoring of soil pathogen populations will be necessary to adequately evaluate effectiveness of this new fumigant, with results applicable to Montana nurseries as well.

Cylindrocarpon Root Disease

This disease occurred on containerized conifer seedlings at most nurseries. Incidence has been higher on containerized western white pine seedlings at the Plum Creek Nursery, Pablo, than other nurseries. Affected seedlings are often not killed by the pathogen; however, fine roots are decayed. Infected seedlings often do not show disease symptoms and inadequate root systems are detected only during lifting.

Miscellaneous Nursery Diseases

Most nurseries in Montana have repeated occurrences of grey mold, Sirococcus blight, Phoma blight,and Pythium root disease. Intensity of these diseases has varied from year to year at different nurseries. Grey mold can be found on containerized western larch and spruce seedlings toward the end of the growth cycle at most nurseries. Sirococcus and Phoma blights are fairly common on bareroot pine seedlings at the Champion Nursery in Plains and the Montana Department of State Lands Nursery in Missoula. However, losses from these diseases were not extensive during 1988.

Stem Decay

Indian Paint Fungus

At the request of the Clearwater NF, a computer model which predicts volume loss due to stem decays in grand fir stands was evaluated for use on the Clearwater NF and State lands in the Clearwater area. The model was developed by Region 6 and the Pacific Northwest Experiment Station for stands in Oregon and southeastern Washington. The Clearwater, TCFPM, and Idaho Department of Lands cooperated in sampling grand fir stands for volume loss to Indian paint fungus and other heartrot-causing fungi. The model was found to reliably estimate stem decay in 40- to 90-year-old grand fir stands in the Clearwater area. It will also be tested for its applicability in Montana, where stem decay due to the Indian paint fungus is the major cause of defect in mature true fir and hemlock stands.

Vascular Wilts

Dutch Elm Disease

Incidence of Dutch elm disease increased in 1988 in some cities east of the Continental Divide. In Great Falls, over 700 American elms were removed during the summer months, with 300 additional removals pending over the winter. There, in 1987, 155 elms had been reported as possible symptomatics. In Billings, where an active sanitation program has been in progress since 1979, 213 infected elms were removed, the lowest number since 1980. Approximately 4,600 elms have been removed from the city over a 10-year period.

Foliage Diseases

A number of foliage diseases were commonly reported and observed in Montana forests, but were of little economic consequence. They included Rhabdocline and Swiss needle casts of Douglas-fir, larch needle blight, lodgepole pine needle cast, and ponderosa pine needle cast. This last disease rarely kills its host, but has been particularly unsightly along the scenic west shores of Flathead Lake.

Abiotic Disease

Drought

Drought-associated damage was apparent at many western Montana locations by early summer. Several species were affected, including Douglas-fir, western redcedar, and ponderosa pine. Sapling and pole-sized Douglas-fir appeared most affected. Both tree mortality and top kill were common, especially on the drier sites. Branch and stem cankers were present on some Douglas-fir, but were likely the result of predisposition by drought.

COMMON AND SCIENTIFIC NAMES

Insects

Ash bark beetles	*Hylesinus* spp.
Douglas-fir beetle	*Dendroctonus pseudotsugae* Hopkins
Douglas-fir tussock moth	*Orgyia pseudotsugata*(McDunnough)
Fir engraver	*Scolytus ventralis* LeConte
Forest tent caterpillar	*Malacosoma disstria* Hubner
Gypsy moth	*Lymantria dispar* (Linnaeus)
Lodgepole terminal weevil	*Pissodes terminalis* Hopping
Mountain pine beetle	*Dendroctonus ponderosae* Hopkins
Pine butterfly	*Neophasia menapia* (C. & R. Felder)
Pine engraver	*Ips pini* (Say)
Pine sawyer	*Monochamus* spp.
Spruce beetle	*Dendroctonus rufipennis* (Kirby)
Western balsam bark beetle	*Dryocoetes confusus* Swaine
Western pine beetle	*Dendroctonus brevicomis* LeConte
Western spruce budworm	*Choristoneura occidentalis* Freeman

Diseases

Annosus root rot	*Heterobasidion annosum* (Fr.) Bref.
Armillaria root rot	*Armillaria ostoyae* (Romagnesi) Herink
Cylindrocarpon root rot	*Cylindrocarpon* spp.
Damping-off, root disease	*Fusarium* spp., *Pythium* spp.
Diplodia shoot blight	*Diplodia pinea* (Desm.) Kickx.
Douglas-fir dwarf mistletoe	*Arceuthobium douglasii* Engelm.
Dutch elm disease	*Ceratocystis ulmi* (Buisman) C. Moredu
Feather root rot	*Perenniporia subacida* (Pk.) Donk
Fusarium root disease	*Fusarium oxysporum* Schlect.
Grey mold	*Botrytis cinerea* (Fr.) Pers.
Indian paint fungus	*Echindontium tinctorium* E. & E.
Larch dwarf mistletoe	*Arceuthobium laricis* (Piper) St. John
Lodgepole pine dwarf mistletoe	*Arceuthobium americanum* Nutt. ex Engelm.
Lodgepole pine needle cast	*Lophodermella concolor* (Dearn.) Darker
Phoma blight	*Phoma* spp.
Ponderosa pine needle cast	*Elytroderma deformans* (Weir) Darker
Rhabdocline needle cast	*Rhabdocline pseudotsugae* Syd. and *R. weirii* Parker & Reid
Sirococcus blight	*Sirococcus strobilinus* Preuss
Swiss needle cast	*Phaeocryptopus gaeumannii* (Rohde) Petrak
White pine blister rust	*Cronartium ribicola* Fisch

COOPERATIVE TRAINING

Personnel from the USDA Forest Service, Northern Region and the Montana Department of State Landss conduct training programs to assist field-going personnel and forest managers in detecting, identifying and managing forest pests. The current training program consists of three parts: basic sessions in which field identification and life cycles of pests are emphasized, advanced sessions in which management alternatives are discussed, and recreation sessions which discuss insect and disease problems in campgrounds and recreation areas. The basic session is designed for field-oriented personnel, such as stand exam crews. The advanced session is designed primarily for silviculturists or others involved in developing silvicultural prescriptions or management plans. The recreation session is designed for campground and recreation area managers.

In 1988, two training sessions were held in Kalispell. A basic session was held in June and an advanced session in August.

The training schedule for 1989 is as follows:

Identification Session: Missoula, June 7-8
Management Session: Missoula, October 3-5

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